GSJ: Volume 11, Issue 1, January 2023, Online: ISSN 2320-9186
www.globalscientificjournal.com

PREPARATION AND PHOTOCATALYTIC APPLICATION OF ZnO SEMI-CONDUCTOR ON GLYSPRING USING UV-IRRADIATION

*Nasiru Aminu Rano[1], Mausul Umar[2], Hammashi H. Lodma[3], Kawuwa Bakari[4],
Paul Samuel[5]
[1,2,3,4,5]Department of Chemical Sciences, Federal University of Kashere, P.M.B 0182 Gombe State, Nigeria
*Corresponding Author E-Mail; nasiru.rano@fukashere.edu.ng

Abstract— *ZnO semiconductor was prepared by Sol-gel method. The presence of the broad lines of the peak in its XRD pattern shows that the material consists of particles in Nano scale range. The heterogeneous catalytic structure through ZnO semiconductors have the capacity to work efficiently and effectively for water treatment. Glyspring was degraded without and with the prepared ZnO catalyst using UV-Light irradiation with time variation. The result obtained showed that the photo degradation activity of Glyspring without and with ZnO semiconductor after 60 min was found to be 22.50% and 32.33% respectively. After 120 min interval, the efficiency increases to 59.98% and 73.50% respectively. This indicate that ZnO semiconductor has the potentials of degrading Glyspring more effectively and less time consuming compared to its degradation in the absence of catalyst.*

Keywords— *Degradation, Catalyst, Glyspring and Semiconductor.*

I. INTRODUCTION

Recently, photocatalysis has attracted more interest due to their potential application in environmental remediation and solar energy conversion. Wide band gap semiconductor materials, such as TiO_2, ZnO, need ultraviolet (UV) light activation for photocatalysis application, which cannot make full use of sunlight energy. Therefore, many efforts have been paid for exploiting visible light-driven photocatalysts (Yanping Liu et al., 2019).

The demand for good quality water by both human and animals (aquatic organism included) have continued to increase with increasing world population and industrial activities. Industrial activities have generated a significant number of pollutants which threat both surface and groundwater (Aguilar *et al.*, 2011). Many polluting substance such as industrial waste and effluent are highly toxic, the wastewater released from industries contains highly hazardous and colored pigments (Azad et al, 2017). It has been reported that the presence of herbicides and related agrochemical compounds in water as contaminants have been a common observation all over the world right from the middle of the twentieth century. The United Nations estimated that less than 1% of all the herbicides used in agriculture actually reach the crops. The remaining contaminates the land, air and particularly the water (Readman et al. 1993, Kopling et al. 1996 and Meyer et al. 1996).

The use of herbicides in crops is a common practice throughout the world and is considerably high in countries having agro-based economy like India. It is worth mentioning the fact here that herbicides are highly toxic and non-biodegradable; tend to accumulate in the environment with deleterious consequences (Sanghi et al., 2001). Increasing herbicides application and improper wastewater disposal methods are of concern for the fresh water resources (surface and ground water), coastal and marine environments.

Study Area

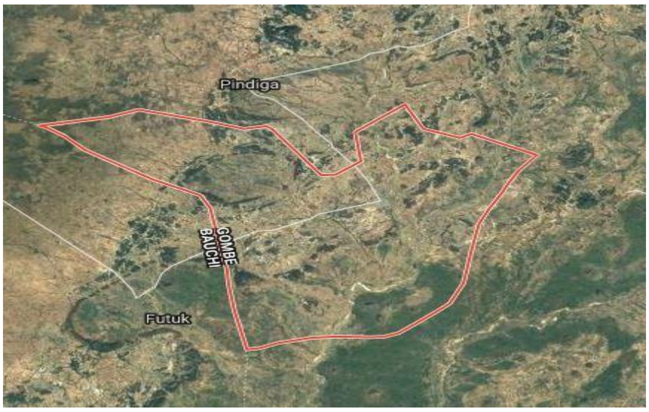

Fig. 1. Map showing the study location

II. MATERIALS AND METHOD

Sampling

480g Glyspring (glyphosate 41% SL) was purchased from Minangi Agro Chemical shop in Gombe main market and pure zinc oxide (ZnO) catalyst was obtained from chemistry laboratory, Gombe state university.

Calibration of Standard

From the stock solution of Glyspring, desired concentration of standard solution was prepared by serial dilution. Calibration was performed with different standard concentration (10, 20, 30, 40 and 50) ppm, the absorbance of each sample was obtained. 30ppm was used for the whole experiment as it was found to have the highest absorbance (Fernandes et al., 2017)

Preparation of Standard Solution

Portion of Glyspring (30 ppm) was weighed using measuring cylinder and transferred into a volumetric flask, deionized water was added to make a solution. The beaker was wrapped with aluminum foil to avoid penetration of light. The wavelength was analyzed using absorbance spectrophotometer and recorded. (Sorolla et al., 2012)

Preparation of ZnO Sol Gel

Propan-2-ol was used in dissolving 0.4 g Zinc acetate at 50-60^{0}C. The solution was stirred thoroughly. Using the same temperature, propan-2-ol was again used to dissolve 10 mg of Sodium hydroxide (NaOH) and the solution was stirred continuously. The two solutions were then mixed together in an ice bath. After continuous stirring, the solution is then kept in a water bath for 1 hr to cool. (Rusmidah et al., 2008)

Photo-catalytic Degradation of Glyspring in the Absent of Catalyst.

20 ppm solution of Glyspring was prepared and stirred gently to have a homogeneous mixture. Some portion of the solution was transferred to a beaker and wrapped with aluminum foil to avoid light penetration, and placed on a magnetic stirrer; UV bulb was inserted into the solution. The absorbance of the solution was recorded at each time interval (10, 20, 30, 40, 50, 60, 80, 100 and 120) minutes (Ghaida et al., 2018)

Photo-catalytic Degradation of Glyspring in the Presence of Catalyst

20 ppm of Glyspring solution was prepared and stirred gently to have a homogeneous mixture. Some portion of the solution was transferred into a beaker and with aluminum foil to avoid light penetration and placed on a magnetic stirrer, 0.1g of catalyst (ZnO) was added to the solution and UV bulb was inserted into the solution. Some portion of the solution was pipette at regular time interval of (10, 20, 30, 40, 50, 60, 80,100 and 120) minutes and filtered. The absorbance of the solution was recorded. (Ghaida et al., 2018)

III. RESULT AND DISCUSSION

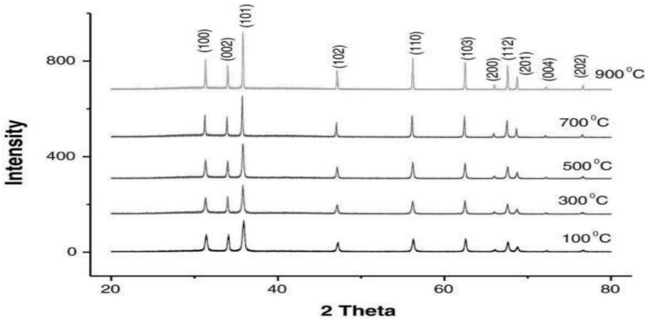

Fig. 2. XRD pattern of prepared ZnO nanoparticles reproduced from ref.5

The presence of the broad lines of the peak shows that the material consists of particles which in nano scale range. From figure 2, the full-width at halfmaximum, position and the intensity of the peak can be determined. The diffracted peaks which are seen at 31.83°.34.52°, 36.33°, 47.63°, 56.71°, 62. 96°, 68.13°, 69.18° have been acutely indexed as hexagonal wurtzite phase of ZnO. (Khoshhesab et al., 2011). It has a lattice constant a = b = 0.324 nm and c = 0.521 nm. (JCPDS, 1977). It also prove that the synthesized nano-powder does not contain impurities, this is because it does not have any characteristic XRD peaks apart from ZnO peaks.

Photocatalytic Degradation of Glyspring in the Absence and Presence of Catalyst

Table 1: Degradation of Glyspring in the Presence of Catalyst

Time (min)	Concentration (ppm)	%degradation	$\frac{Co}{Ct}$	In $\frac{Co}{Ct}$
10	29.70	1.00	1.010	0.009
20	28.04	6.53	1.069	0.067
30	24.20	19.33	1.239	0.214
40	23.17	22.76	1.294	0.257
60	20.30	32.33	1.477	0.390
80	14.48	51.73	2.071	0.728
100	8.48	71.73	3.537	1.263
120	7.95	73.50	3.773	1.327

Table 2: Degradation of Glyspring in the Absence of Catalyst

Time (min)	Concentration (ppm)	%degradation	$\frac{Co}{Ct}$	In $\frac{Co}{Ct}$
10	29.92	0.26	1.002	0.0019
20	29.40	2.00	1.020	0.0198
30	28.02	6.60	1.076	0.0732
40	25.54	14.86	1.174	0.1604
60	23.25	22.50	1.290	0.2546
80	13.44	55.20	2.232	0.8028
100	12.08	59.73	2.480	0.9080
120	12.01	59.96	2.497	0.9150

% Average degradation = (Co-Ct)/Co X 100
Where: C_O = Initial concentration
Ct= final concentration

Discussion

Degradation in the Absence of Catalyst

The evaluation of the degradation of Glyspring under the effect of UV irradiation was carried out with time variation of 10,20 30,40,,60,80,100 and 120 minutes using maximum absorption spectrum of 190 nm and the concentration of 20 ppm without the addition of catalyst. Table 1 showed the degradation of Glyspring without catalyst with time variation. From the result obtained, it's shown that the percentage degradation is slightly increasing with increase in time from 10 minutes (0.26%) to 120 minutes (59.96%). These shows that the degradation of Glyspring occur even in the absence of catalyst but the percentage degradation was not large enough which is an indication that with increasing irradiation time, the rate of degradation of Glyspring increased due to the formation of OH radicals.

Degradation in the Presence of Catalyst

As with the degradation without the addition of catalyst, the evaluation of the degradation of glyspring was also done with time variation of 10minutes to 120 minutes but in this case with the addition of 0.1g optimized ZnO semiconductor on a maximum absorption spectrum of 190 nm and a concentration of 20 ppm. Table 2 shows the degradation of paraquat in the presence of ZnO semiconductor with time variation which shows that there is large increase in percentage degradation from 10 minutes (1.00%) to 120 minutes (73.5%). Degradation is achieved at 60 minutes (32.33%) which is an indication that the percentage degradation of Glyspring in the presence of ZnO semiconductor is more effective and less time consuming compared to its degradation at the absence of catalyst. The amount of UV irradiation absorbed by the semiconductor with time variation result in the speedy degradation of glyspring.

IV. CONCLUSION

Based on these results, UV irradiation degraded Glyspring in the absence of a semiconductor with lower percentage of 0.26% at 10 minutes and 56.96% at 120 minutes and overall average of 27.64%, but the degradation is more effective in the presence of a semiconductor with the percentage degradation of 1.00% at 10minutes and 73.5% at 120 minutes with the overall average of 28.40%. These showed that degradation of glyspring is not efficient under UV irradiation for a short period of time but over long time period and also under ZnO semi-conductor serve as catalyst to speed up the process.

REFERENCES

[1] B. Ochoa, L. Ramos, A. Gabvbay. (2016). "Electrokinetic Treatment of Polluted Soil at Pivot Level Coupled to an Advanced Oxidation Process of its Waste Water*". Journal of Physican and Chemistry of the Earth*. Vol 91, pg 68-76

[2] D. Smazna, S. Shree, O. Polonskyi, S. Lamaka. (2019)."Mutual Interplay of ZnO micro and nanowires and methylene blue during cyclic photocatalysis process". *Journal Chemical Eng.* Vol. 7, pg 13-16.

[3] Bono, D. Krishnaiah, G. Li Puma, J.G. Collin,(2008) "Preparation of Titanium Dioxide Photocatalyst Loaded onto Activated Carbon Support Using Chemical Vapor Deposition": A Review Paper, *Journal of Hazard. Materials*. Vol. 157, pg 209–219.

[4] Aguilar C.A., Montalvo .C., Ceron .J.G and Moctezuma .E. (2011), "Photocatalytic Degradation of Acetaminophen". *International journal of Environmental Research*. Vol. 5(4), page 1071-1078.

[5] Kudo, Y. Miseki, (2009) "Heterogeneous photocatalyst materials for water splitting Chem". Soc. Rev. 38 253–278.

[6] Kumar and G. Pandey (2017) "A Review on the Factors Affecting the Photocatalytic Degradation of Harzadous Material", *International Journal Material Science And Engineering*. Vol. 1 issue 3 1(3):

[7] D.Beverley D, K. Devagi & O. Michael, (2013)., "Titanium dioxide photocatalysis for pharmaceutical wastewater treatment," Environ chem. Let 12:27-47 Doi 10.1007/013-0428-0.

[8] EPA February 2011, Pesticides Industry Sales and Usage 2006 and 2007

[9] Shahram M., Bahar R., Ali M., and Parviz A. (2014), "Removal of Permethrin Pesticide from water by chitosan-zinc oxide nanoparticles composite as an adsorbent". *Journal of Saudi Chemical Society*. Vol 18 pg 348-355

[10] Hapeman-Somich,C. J. (1991), "Mineralization of Pesticide Degradation Products, ACS Symposium Series 459, 133-147,

[11] Gimsing, A.L., Szilas, C. and Borggaard, O.K. (2007) "Sorption of glyphosate and phosphate by variable-charge tropical soils from Tanzania", *Geoderma*, vol. 138, no. 1-2, pp. 127-132.

[12] Goswami, Y., "Engineering of solar photocatalytic detoxification and disinfection processes," Advances in Solar Energy, vol. 10, pp. 165-210 (1995).

[13] Huston, P.L. and Pignatello, (1999) "Degradation of selected pesticide active ingredients and commercial formulations in water by the photo-assisted Fenton reaction", *Water Research*, vol. 33, 1238-1246.

[14] Jegannathan KR, Nielsen PH (2013) Environmental assessment of enzyme use in industrial production—a literature review. J Clean Prod 42:228–240

[15] Konstantinou IK, Albanis TA (2004) TiO2-assisted photocatalytic degradation of azo dyes in aqueous solution: kinetic and mechanistic investigations. Appl Catal B 49(1):1-1

[16] Lewis, J. A., Papavizas, G. C. & Hora, T. S. (1978). Effect of some herbicides on microbial activity in soil. *Soil Biology and Biochemistry*, Vol. 10, No. 2, (June 1977) 137-141, doi: 10.1016/0038-0717(78)90084-6

[17] Linsebigler, A., Lu, G., & Yates, J., "Photocatalysis on TiO_2 surfaces: principle, mechanisms, and selected results," Chemical Review, vol. 95, pp. 735-758 (1995).

[18] M. Gancheva, M. Markova-Velichkova, G. Atanasova, D. Kovacheva, I. Uzunov, R. Cukeva, ―Design and photocatalytic activity of nanosized zinc oxides‖, Applied Surface Science, Elsevier, Vol. 368, 2016, pp. 258-266.

[19] Madhun, Y. A. & Freed, V. H. (1990). Impact of pesticides on the environment, In: *Pesticides in the Soil Environment: Processes, Impacts, and Modeling*, Cheng, H. H., (Ed. SSSA Book Series No. 2), 429-466, Soil Science Society of America, Madison, WI

[20] Manassero, A., Passalia, C., Negro, A.C., Cassano, A.E. and Zalazar, C.S. (2010) "Glyphosate degradation in water employing the H2O2/UVC process", *Water Research*, vol. 44, no. 13, pp. 3875-3882.

[21] Mansor, M. (1996) "Noxious floating weeds of Malaysia", *Hydrobiologia,* vol. 340, no. 1-3, pp. 121-125.

[22] Merás, I.D., Díaz, T.G and Franco, M.A (2005) "Simultaneous fluorimetric determination of glyphosate and its metabolite, aminomethylphosphonic acid, in water, previous derivatization with NBD-Cl and by partial least squares calibration (PLS)", *Talanta*, vol. 65, pp. 7-14.

[23] MeisamHasanpoor, Mahmood Aliofkhazraei, Hamid Delavari H., (2016) ―In-situ study of mass and current density for electrophoretic deposition of zinc oxide nanoparticles‖, Ceramics International, Elsevier, Vol. 42, pp. 6906-6913.

[24] Meyer B and Marx D (2003) *Phys. Rev*. B **67** 035403

[25] Muneer, M. and Boxall, C. (2008) "Photocatalysed degradation of a pesticide derivative glyphosate in aqueous suspensions of titanium dioxide", *International Journal of Photoenergy,,* pp. 197346.